ELECTRICITY IN THE SERVICE OF MAN.

BY A. N. BRADY.

THE waterfalls have been at work for untold ages. Within a generation man has harnessed their force, converted their energy into electricity and compelled nature to do the work of the world. In thirty years electrical science has advanced from the field of discovery and invention to practical application to the arts and industries, developing a tiny laboratory spark into a powerful agent which moves the wheels of industry and commerce. The telegraph and the arc light were known before; but the telephone, the electric railway, the incandescent lamp, and the electric motor have been used only within a generation.

Electric cranes and hoists would build the Pyramids to-day with ease and dispatch. The thousands of unskilled workmen who actually wore out their lives in that monumental labor of dead ages paid the penalty of ignorance. Economy and concentration of effort are the lessons of the twentieth century.

The automobile truck, wheeling tons of dead weight from place to place under the guidance of a driver whose only labor is to pull a lever, is an example in everyday life of an electric machine doing safely and economically work which was but, recently the wearisome task of man and beast. Merchandise will soon be collected by electrically operated express wagons, transferred to electrically propelled freight cars, and whirled from New York to Chicago at a speed of ninety miles an hour, over trunk lines whose problems of electrical equipment and maintenance will have solved themselves.

A man who, twenty-five years ago, predicted that everyday business would be carried on to-day between New York and Chicago by direct vocal communication over a telephone wire, would have been scoffed at. It is difficult to think of any new

demonstration of the practical use of electricity which shall compare with that. But no man can deny the possible achievement of a greater marvel. All the while, electricity is coming closer home to the masses of the people, lifting their burdens, shortening and smoothing their journeys, lighting their streets and roads, and making their working tasks less difficult.

Of the two quarrymen who pierced a ledge of rock ten years ago, one holding the drill and the other plying the sledge-hammer, one only is now needed to operate an electric drill, while doing ten times the work. The laborer's task is lightened; his partner has found an equally improved opportunity; they both get more wages; and their employer gets out more rock. A few years ago, the drawbridge at Hamilton Avenue over the Gowanus Canal, in Brooklyn, N. Y., was operated by from three to five men working on a capstan requiring from four to five minutes to complete the operation. An electric motor has been substituted, which closes the bridge in fifty seconds, and the services of but one man are needed.

Traction and lighting are the two applications of electrical energy to every-day life which are most in the public eye. Twenty years ago there were no electric cars in the United States.

The application of electricity to trunk line railway traction is believed by many experts to be a development of the near future. The superior utility and flexibility of electric cars for traffic within, without and between cities, under certain conditions, is not denied. Problems of cost and convenience, which increase in importance with the length of the lines operated, are by no means insoluble. Because we do not see our way now to the economic substitution of electrical for steam locomotives on a four-track trunk line between two centres of American population, it does not follow that the change will not be made eventually. The long, luxurious sub-trolley car, handsomely fitted and brilliantly lighted, which carries its passengers along a well ballasted track at the rate of twenty miles an hour in many American cities, is a far greater advance over the musty little horse car which was in use prior to 1884 than the electric train of parlor cars will be over the steam equipment, the passengers in the former making the run from New York to Chicago between daylight and dark.

Of course, the enormous investment represented by the steam locomotives of the trunk line railway systems must be borne in mind in considering this substitution of electrical traction. But to my mind the most important consideration in the profitable use of electricity on trunk line railways is the necessity for dispatching frequent trains, made up of a smaller number of cars, instead of infrequent trains made up of a larger number of cars. The latter is the steam railroad method, by which each train pays for itself. The electrical plant, representing a great, continuing investment, would be earning no return at all except while trains were in operation. The more trains run, whether consisting of one, three, five or any number of cars warranted by the demands of the traffic, the better the return on the investment. The same reasons which would supersede steam by electricity on railways would render the superseded locomotives comparatively useless elsewhere. A syndicate in Berlin is experimenting in high speed and long distance traffic, to determine possibilities and limitations by actual test.

There are two hundred miles of inter-urban electrical roads running out of Indianapolis alone, connecting the principal cities of the Indiana natural-gas belt. The forty mile electric railroad from Albany to Hudson is in commercial operation. So is the Chicago-Joliet line, of about equal trackage. Years ago, the Pennsylvania Railroad and, to a greater extent since, the New York, New Haven & Hartford Railroad, successfully introduced the overhead trolley on their suburban feeders. The Cascade Division of the Great Northern, the Illinois Central and the Chicago & Great Western have made decided advances in this direction recently. The consolidation of trolley companies in New Jersey, resulting from community of interests, tends as elsewhere to the operation of electric trunk lines between large cities. Similar consolidations of electric railways out of Cleveland and of trolley roads in many localities on a smaller scale look toward the same end. An electrical trunk line passenger railway is projected from Salt Lake City to San Francisco. Indeed, the practical operation of these systems of suburban, short-haul feed lines tends directly to the draining of surrounding territory toward a central point, from which a long-haul by the steam line to another central point facilitates distribution.

In densely populated portions of Great Britain, where the

railway companies own their own roadbeds and are confronted by no grade crossings which limit efficient intercommunication, electric traction can be economically applied to the hauling of passenger and freight trains before the problem is successfully solved where traffic conditions are more difficult. When trains are thus propelled, lighted and heated, supplied with electric bells and fans, dispatched by telephone instead of telegraph, the moving train being kept in continuous telegraphic communication with the outer world, the railway traveller will be in a position to appreciate more fully the services of electricity.

One of the most interesting of the electrical traction systems now in operation is the elevator service. Every great city has thus its vertical, as well as horizontal, passenger railways. Cars that are hauled up and down the streets are to-day scarcely more essential to the business life of New York City than are the cars propelled up and down the elevator shafts of tall buildings, which have been referred to as a traction system on a grade of ninety degrees. There are in New York more than two thousand electrically operated elevators, using more than 15,000 horse power. The vertical trackage of these electric cars increases continually in large centres of population, where the value of real estate is great. In fact, distinct types of business and residence buildings, as, for instance, the "elevator apartment," have been thus developed. Modern buildings not electrically equipped throughout are severely handicapped in the competition for tenants.

Electricity confers one of its greatest benefits on man by furnishing him the most perfect and the most useful light known. Under ground and under water, at midnight and at midday, in the street, in the workshop and in the house, this light is made available by various ingenious devices. In towns of only a few thousand inhabitants, as well as in all large cities, the streets are illuminated by arc lamps. The glare and flicker of the early arc lamps were considered a necessary accompaniment of all electric lighting, a defect which later improvements have eliminated. The improved incandescent light has recently been pronounced by experts at the University of Heidelberg as the most sanitary of all methods of artificial illumination. The incandescent lamp has, indeed, been perfected until its light may now be modulated comparably with that of an oil lamp or gas jet. The lighting effects which were conceded to be one of the most striking features of the

Pan-American Exposition at Buffalo, were produced by small units of light—eight-candle-power incandescent lamps—instead of the usual method of arc lamps of high candle power.

The growth of electrical industries interested President McKinley. In his last speech, delivered in Buffalo on the day of the tragedy, he spoke of the necessity of the construction of a Pacific cable. Electricity was called promptly in to minister to the comfort of his sickbed. When the physicians in attendance thought the temperature of the sickroom should be reduced, an electrical fan installation was effectively cooling the air within a few hours. On the same day, a long distance telephone message from the Milburn residence in Buffalo to the Edison laboratory started on its way from Orange, N. J., under the great electrician's own supervision, the best attainable Roentgen-ray apparatus, which was received in Buffalo the next morning.

In many of the cotton factories of South Carolina, where labor is cheap, the most economical power is derived from neighboring water courses, the spinning machinery being operated by electric motors. In the armor-plate factories, electric cranes pick up great masses of steel and silently shift them from the furnace to the rolls. Electric drills pierce the earth for coal and metal-bearing ores. The ores thus extracted are crushed by electricity and refined by the same agency. Into the irrigating channels of the arid regions of the Southwest, water from the distant hills is forced by electrical pumps. The water we drink is purified by electrolysis. Electro-chemistry is preparing many of our drugs and supplying many chemicals used in the arts. In all the domain of physical science, the most minute and accurate measurements are those made by electrical apparatus; and the electric current distributed by supply companies is measured and paid for on the indications of accurate and efficient electric meters.

Economy of production and distribution is the first business lesson. The current generated at a supply station in a great city may now be used throughout business hours in moving electric elevators, furnishing motive power to shops and industrial establishments, as well as in lighting myriads of lamps in shops and residences. Thus by degrees may be overcome the difficulty with which electrical supply companies have to contend in securing a return on their investment. Where current is distributed

for private or residential lighting only, the small number of hours over which this demand for lighting extends is an important factor in determining the cost of the service. As new commercial applications and uses for the electric current are developed, extending its use over a greater number of hours, the cost of generating and distributing becomes less, in turn inviting new applications and extensions.

The public mind is already so accustomed to the successful performance of almost prodigious tasks by electrical appliances that no special attention is aroused by the construction to-day of electrical plants which would have amazed the world a few years ago. Such, for example, are those of the New York Edison Company, the Metropolitan Street Railway Company and the Manhattan Railway Company, in which enormous boiler plants generate steam for operating engines of great power, all whose force is spent in producing electricity for generating heat, light and power.

In telegraphy the Western Union and Postal systems may be estimated at $150,000,000, employing 100,000 people. Every railroad system has its telegraph lines. The ocean cables, in which there is a good deal of American money invested, approximate 200,000 miles. There are 800 cities with fire telegraphs. It is within bounds to say that a total of $250,000,000 is invested in telegraphy.

From the time of Bell and Gray in 1877, the telephone business has grown to $400,000,000. The Bell system alone is declared to represent $200,000,000, with 2,500 exchanges and offices, and 1,700,000,000 connections a year. Its exchanges have over 26,000 employees.

In electric lighting, the capitalization of central station companies, isolated, municipal and ship-lighting plants, reaches $1,200,000,000. There are nearly 3,000 companies, with obligations of about $750,000,000, of which half is bonded. There are not many less than 30,000,000 incandescent lamps connected, while more than 600,000 arc lamps are doing duty. Central station earnings have been estimated at over $50,000,000. Electric lighting employs about 150,000 people.

Electrical street railways represent a capitalization of nearly $2,000,000,000. In 1897, they were earning $150,000,000 gross, and 220 of them showed in 1898 $130,000,000 gross earnings, at

which rate the earnings of electrical street railways of the United States were $180,000,000 in 1900, say four per cent. on the entire investment. Their employees number 150,000.

It is estimated that over $100,000,000 are invested in electrical mine plants, $150,000,000 in power plants, and about $50,000,000 in electro-plating establishments.

The grand total of $4,000,000,000 invested in electrical industries in the United States has been materially increased in the year 1901.

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